Office Equipment Auditing

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What one does in the course of an audit of office depends on the purpose of the exercise. These can vary from equipment counting/inventory, to estimating potential or actual energy savings. There is also a distinct difference between auditing of computers and monitors, and of imaging devices (printers, copiers, and fax machines). Appendix D of the "User Guide" to power management provides a discussion of different approaches to computer power management auditing. It is reproduced at the end of this discussion.

General Auditing Issues

It is common for the senior people in an office setting to have enclosed offices with doors on them. For night time audits, this prevents checking these offices if they are locked and if the auditors don't have a master key for the building. For daytime audits, the same applies when the office occupant is not present, or when there, it is more disruptive to the occupant to have to knock on the door. For these reasons, the most complete audits are those done at night with a master key.

Workers often suspicious of equipment auditors/enablers. Most people have never previously met someone who is highly aware of and concerned about for office equipment energy, so may doubt your explanation of what your purpose is. Letters from management, from 'names' that people recognize and defer to, are often helpful or necessary to get and maintain access to office areas and to particular equipment.

Daytime audits have several advantages. People can be queried as to whether certain equipment is used much or at all. People can be asked if it is okay with them to enable or change power management on a device, or if there is a program of active enabling, if there is any reason to **not** enable it. On some copiers, the configuration cannot be checked while it is warming up, so on these, daytime audits can avoid this delay. Daytime audits should be conducted during regular work hours, not to early or late in the day, and avoiding days near holidays that may be anomalous.

Night-time audits have other advantages. For PCs, they should be conducted at least half an hour (preferably a full hour) after workers have left for the day. For imaging devices, reliable data can only be taken after at least two (preferably three) hours to allow them time to allow their longer delay times to take effect. It may be helpful to promise to not make any changes in equipment configuration, to alleviate fears of the person authorizing the audit, and to avoid getting blamed for problems unrelated to any changes made by the auditor.

The nomenclature used for power management varies across brands and types of equipment, but "sleep", "suspend", "energy saver", "power saver" are all common terms.

Some suggested 'rules of thumb' for quick and effective auditing follow. If equipment is unplugged from power, assume that it is not in use and so don't include it in the inventory. If equipment is exceedingly old or broken, but still plugged in, consider assuming that it is similarly obsolete. Be prepared for equipment such as laptops (possibly without a power cord), and laptop 'docking stations', with or without the laptop present. Computers operated as servers usually operate 24 hours/day, 7 days/week, so should be counted for total electricity use, but not with regular PCs as they are likely to have no power management opportunities. Be prepared for anomalous situations, such as a monitor plugged in to the wall and on, but not connected to a PC.

PC and Monitor Auditing

The excerpt from the "User Guide" (at end of this discussion) provides an introduction to auditing of PCs and monitors. Some barriers to effective auditing that we found include:

• Windows "Log-on" and screensaver passwords can prevent access to BIOS screens or control panels to check or change power management settings.

• Glare screens on monitors often cover the power indicator and/or the switch. This can reduce the likelihood that users manually power off their monitors, or notice that it remains on at some level (whether full-on or in low-power). It also makes auditing more difficult.

• PCs that are non-branded, either home-built or put together by small companies from components. These can be anonymous from the outside as to their vintage and processor type. Similarly, some major components of machines can be replaced, giving them markedly different characteristics than appears from the box. In some cases, only the case is reused, so that the whole inside is different.

Printer, Copier, and Fax Machine Auditing

Auditing of imaging devices (printers, copiers, and fax machines) for power management status is in some ways easier and in other ways more difficult than auditing of PCs and monitors. It is generally easier to identify the brand and model, and easier to determine if it is ENERGY STAR compliant. It is often more difficult to find power management controls without having the manual to refer to, but the manual is more likely to be present than it is with PCs or monitors. Imaging devices are more likely than PCs—but less likely than monitors—to indicate their power management status. Delay times on printers and copiers can be up to several hours, so that night audits need to occur later than with PCs and monitors. Finally, unique among office equipment, copiers can turn themselves entirely off, so that it can be impossible to tell if it was manually turned off, or turned itself off[1] .

Imaging devices are generally shared among users rather than being used solely by one person, making behavioral issues more complicated. On the other hand, the internal functioning of power management is simpler than it is with PCs and so less likely to fail to operate when properly configured. We are unaware of an imaging device failing to power manage when enabled except when it is in some error mode such as a paper jam or an open door. Very old imaging devices (e.g. more than 8 years old) are more common than very old computers, and "odd" devices are also more common, such as large format printers or copiers, or microfilm printers.

"Poking around" the controls for imaging devices almost always reveals previously unknown features or information, and so well worth doing for those inclined. For example, many fax machines have a feature to automatically reduce incoming documents to fit on the page, which avoids using excess paper when faxing between countries that use a different size of standard paper. Many copiers have a feature to automatically turn on or off according to a timer, varying with the day of the week. Printing out configuration or test pages can also reveal interesting information. For example the 'HP Copyjet Self Test Page' reports the number of 'Power Cycles' that the machine has gone through, which combined with the date of purchase, should indicate how often it is turned off.

Fax Machines

In the audits of office equipment at the City of San Francisco, no ENERGY STAR fax machines were found to have their power management disabled. Fax machines are the most difficult imaging device to audit, and in the absence of the manuals, many of the machines we saw could not be checked. So, while this experience is not conclusive (that fax machines are not disabled), it does appear that power management disabling is much less of a problem with fax machines than it is with printers and copiers.

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[1] A few PCs can turn themselves off at a specific time, but it is not known to be widely used.

Inkjet or thermal fax machines don't have the fuser roll that laser-based fax machines do that takes considerable power to keep ready. Thus, these types of machines generally meet low-power requirements without any active power management, and so would not have any power management controls to enable or check. Thus, only laser-based machines need to be scrutinized closely.

Fax machines usually have controls that make it difficult to check their configuration without having the manual. One possible shortcut on some models is the feature in which the machine prints out a page of a map of the menu commands; this can show where the power management controls (if any) are located. This is advice is based on just a few models, so you may find machines that don't fit any of the patterns described. Some models can print a page of configuration settings, which may indicate whether a power management control is present, and perhaps how to get to it.

Pre-ENERGY STAR fax machines are not known to have any power management, and so the topic will not even be raised in the manual or elsewhere. At least one ENERGY STAR model we checked (Canon 7000/7500) did not mention power management at all, and was confirmed to attain a low-power mode, so we assume that it cannot be disabled. Another family of models (Panafax UF-550, -560, -770, -880) specifies the power management control with a 'Start' and 'End' time during which power management operates; most of the models we examined were set so start at `00:00` and end at `00:00`. We confirmed that on these models, power management always operate; we presume that this is the default setting. One fax machine (actually a small multi-function device) showed `SLEEP` on the display when audited, and operated with a delay timer to initiate the low-power mode (the delay timer was set to zero minutes, and presumably operated satisfactorily or would have been changed).

Aside from the one model (above) that displays 'sleep', we have not observed fax machines displaying obvious signs of being in a low-power mode. One model turned its fan on when power management was disabled, which was noticeably noisy. This may be because designers were afraid that low-power would be interpreted by some people as meaning that the machine is not fully operable. Alternatively, it may be totally irrelevant to how people use the machine and so the designers saw no point in indicating the mode. As the ENERGY STAR program specifies a default five minutes before most fax machines (those <= 14 ppm) goes into low-power mode, a power meter could be fairly easily used to determine machine's operation, and might be the only way to do this on many machines.

Some multi-function devices are based on fax machine designs and so are likely to have similar characteristics to ordinary fax machines, except for having possibly longer delay times until entering power management modes.

Printers

Inkjet printers use little power when not actively printing, so many meet ENERGY STAR low-power requirements without having to change to a different power mode. Some larger inkjet printers do need to power manage, and one model we saw (HP 1200C) had the power management switch on a small "DIP" switch with unrelated configuration settings. Most inkjet printers have an indicator light to signal that they are on, they typically do not call attention to themselves (with noise, etc.) so much as laser printers. The delay time for an inkjet printer to wake up is short and so not so much of a deterrent to manual turn-off.

For laser printers, different power modes are always needed. Larger printers with alphanumeric displays generally indicate a low-power mode, but the increasingly common 'personal' laser printers lack such a display. The ENERGY STAR maximum delay time until entering power management modes 'as-shipped' ranges from 15 to 60 minutes, depending on printer speed. In our examination of printer delay times, we often found a large variety of delay times for printers of the same model, suggesting that someone had actively changed them since being bought. As we found a considerable minority of laser printers with the power management disabled, reconfiguration of power management controls seems to

happen periodically; why this is the case is not apparent. Most users, when asked about such a printer in their vicinity, are unaware that power management has been disabled.

The largest manufacturer of laser printers is Hewlett-Packard, so a review of power management controls in their printers is useful in itself and may indicate the pattern present in other manufacturers product lines. Most HP laser printers use the "Laser Jet" name. Early Laser Jet printers (e.g. the II, III, 4, and 4P) had no power management capability. All larger HP printers share a similar control structure, with one button to cycle through different "menus" and another one to cycle through different "items" within each menu. Items may hold a switch, a value, or when selected cause an action. When auditing, it is an easy, though mildly tedious, matter to cycle through the various menus and items to locate the power management setting (usually called "POWERSAVE"). Unfortunately, the particular menu has changed over time. It is in the "Configuration" menu in the 4000N, 5si, and 5M(color); in the "Printing" menu in the 5N; and in the "Job" menu in the 4plus, 4si, and 4MV. To audit the setting, use only the 'menu' and 'item' keys. To change it, use "+" or "-" with the 'value' key [CHECK 4si], then Select to set it. You may need to take the printer explicitly 'offline' before starting, and manually put it back 'online' afterwards (some require this, some don't.

Examination of one Lexmark model (an Optra SC 1275) found a similar setup, though a different way of using the keys. The 'menu' key cycles through the menus, but when you come to the desired one 'select' causes the menu key to then cycle through the items. Once the right item is found, 'select' is again used to be able to check or edit it, with 'menu' used to adjust the value, followed by 'return' to end the process. The term "Power Saver" is also used. Other Lexmark Models (N and Lxi) use a common menu system; next to the LCD display are four buttons, and if you select the one next to "Menus", then "Setup Menu", then "Power Saver", you arrive at the power management delay timer.

A final example is the Tektronix Phaser 360 Color Printer. The 'menu' key is used like the 'select' button in the Lexmark example; the "<---" and "--->" keys cycle through menus and selections; and "OK" makes a change permanent (use "Exit" if you don't want to make a change). The power management control is called the "Energy Star Timeout", and it displays "Energy Star Mode" when power managing. All of this is ironic as the printer is not even on the EPA ENERGY STAR lists! (Tektronix is not an ENERGY STAR partner).

Some printers allow the control panel to be 'locked', restricting access to the controls, but this feature seems to be used only rarely.

Copiers

Copiers present the largest range of power management controls and indicators of any type of office equipment. Part of this is due to the wide range in copier sizes, as well as the fact that power management has been present in some copier models for many years. Also, some copiers have very limited displays, and most have some controls designed only for service technicians or specially trained "key operators".

Because copiers usually take a long time to warm up from low-power or off modes, they usually indicate that status. On some, a low-power indicator light turns on or flashes, and commonly, the main display will go dim or off. Copiers with an alphanumeric or graphic display often indicate low-power status on the display with words. Copiers with just a numeric display for copy count and zoom magnification usually have the most obscure controls for power management.

It is often helpful to have the copier manual to refer to; check the sides, back, and insides of the copier to see if it is available. Sometimes there are separate 'user' and 'key operator' manuals; check both.

Copiers with complex displays are more likely to have power management controls that are easily findable without a manual. Examination of the manual may be fruitful, as in the case of key operator codes. On some copiers, the default is no password code, even if one is settable. On others, the default password is listed in the manual and often has not been changed. On many copiers, the only setting is the delay until low-power and/or auto-off. On a few models, the <u>degree</u> of low-power can be set. Many copiers have clocks and the ability to turn on or off at specific times of the day, ofen variable across the day of the week. These weekly timers are rarely used, but should be checked just in case.

For copiers with an auto-off feature, some actually move the switch so that it is indistinguishable from a switch manually turned off. On others, a "soft switch" has the same effect. However, some models leave the switch in a position during auto-off that is different from where it is with manual turn-off, so that they can be distinguished.

For any copier, a good test of its status is so press the "start" key and measure how long it takes to make a copy or to become ready to make a copy. The longer the time, the lower power mode the copier is in.

When a copier is on, default duplex is easy to see from the controls, though if the copier is not in default duplex, try putting a sheet in the document feeder as a few models will only default to duplex when not copying off the glass.

In the San Francisco project, all of the copiers audited had some power management enabled. However, some of them had the auto-off feature enabled, but the accompanying low-power feature disabled. On the other hand, a larger study of copiers found 35% of audited ENERGY STAR copiers fully or partially disabled (some accomplished a low-power mode but failed to automatically turn off).

Many copiers have counters for the number of double-sided copies made in addition to the universal counters of total images. Combining these two allows calculation of the "duplexing rate". The double-sided counters sometimes accumulate one count for each duplexed copy, and on other models accumulate two. It is easy to read the meter, make a double-sided copy and read it again to determine the behavior of your copier. There may also be counters for large-size or color copiers, but on a regular convenience copier, these can generally be ignored.

For both image counting and power management checking, it is often helpful to talk to your service technician, who can often either show how to get at the right controls, or if s/he is reluctant to tell you how to gain access to a service mode, may offer to report the results to you.

[the following extracted from the "User Guide" to power management, Appendix D]

Auditing and Evaluating Power Management in Personal Computers

An audit of the hardware and software computer professionals supervise can help clarify the potential and actual power management capabilities of their equipment . An audit can be of one particular system, or of a large set of systems. When many similar systems are audited, there are economies of scale, but many PC system characteristics need to be individually checked since both hardware and software details can vary for systems which may appear identical.

Audit types

We have divided audits into three types[2], from the most simple to the most rigorous. The procedure for each succeeding level incorporates the earlier levels.

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[2]See Nordman et al., 1995 for further details.

Level One

> Observe brand and model information by visual inspection of the outside of the case, without relying on the machine being on. A level one audit can be combined with power ratings and likely use patterns to indicate overall electricity use rates and potential savings from power management.

Level Two

> Examine configuration settings in any appropriate BIOS screens and control panels, observing the presence and configuration of any relevant software (such as screensavers, video or network card drivers), and potentially contacting the manufacturer for any power management information they can provide. A level two audit indicates the overall degree of enabling and whether some machines are configured in the same or a similar state.

Level Three

> Measure the power drawn by the device over enough time to observe all important power management modes occurring, recording the amount of time between mode changes and the power level at each mode. A level three audit may also include opening the PC case and temporarily removing some expansion cards. A third level audit verifies that potential power management modes actually occur, and that power and timing are as expected from the configuration and equipment inventory.

Guidance

For some equipment, contacting the manufacturer may be necessary to obtain information about how to check, interpret, or change system configuration. From the serial number, the manufacturer can also tell the date of manufacture and the configuration-as-shipped status. For any audit, an initial walk through of the audit area should be done to evaluate the general types of equipment present. It is often easier to conduct audits when most people are not around, such as on nights and weekends.

First level Audit

The first level of audit generally takes only that information visible from the exterior of the device. For the most part this is "nameplate information" found on the back panels of the PC or monitor, particularly the Manufacturer Name, Model Number, Serial Number, Manufacturer Date, and rated current or power draw (in amperes or Watts). Manuals for the PC or monitor may provide information about default power management settings, or if add-on software is provided. Also, check to see if the monitor is plugged into the PC convenience outlet.

Try recording whether the equipment was on during the audit, and if so, what state (e.g. full-on, visibly in suspend, running a screensaver, etc.). This can help indicate how much energy is being saved by power management, and how much more could be saved by enabling more power management or turning equipment off when not in use. Then, if the machine is on and in a suspend mode, press a key or move the mouse and record how many seconds it takes to revive to the full-on state. You can use this information to decide on delay times appropriate to each piece of equipment.

Second Level Audit

A second-level audit begins with rebooting the computer to observe any relevant information (e.g. amount of memory, number and size of hard disk drives) as the system comes up. To determine a model number, it is sometimes necessary to check what type of system the operating system thinks it is running on. It is also helpful to know the version of operating system. You should be able to determine power management details such as the number of power management modes it supports, whether it supports APM, whether power management is enabled (and how), the power management options available and the delay times.

For monitors, you may want to record the number of options for screen saver or other power management software, whether power management is enabled, if video card software is present, the type of screen used for screen saver or screen dim, the number of power management states it supports, and the delay times specified.

Dynamic Testing: Second or Third level

To see if power management actually occurs, it is necessary to turn the system on and wait till delay timers in the system have had a chance to run out and attempt to initiate power management. This can be done with or without power metering, though without one can only observe monitor power management and hard disk drive spin-down. These can be noticed through any delays in returning to full power, or often in the case of the disk, by its sound.

Compare observed times with those listed on the configuration screens (or monitor manuals). Note if screensaver defeats monitor or PC power management; this may require waiting until the screensaver has a chance to begin operation which may be well after the power management begins.

Once the dynamic test is complete, if any changes were made to the power management configuration, return the system to original setup parameters unless the user requests otherwise.

Third Level Audit

A third level audit requires a current or power meter; it is preferable to have two such meters available, to be able to measure both the PC and the monitor at the same time. Because of the effort involved, dynamic testing is most commonly used when there are many machines of similar manufacture so that the lessons learned from studying one will apply to many others.